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Title: MTI LEVEL 1 IMAGE DATA CAVEATS SUMMARY

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MTI Level 1 Image Data Caveats Summary
Version 1.0 (Revised)

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This document gives a brief summary of the artifacts to be found in the Multi-spectral Thermal Imager (MTI) ground imagery data as processed in early May 2001. A more detailed discussion will be found in "The MTI Data Reference Guide for Level 1 Imagery".

On November 1, 2000 the TCAL box, a control system for parts of the MTI system, was lost. As a result the on-board calibration system is no longer operational and the fore-optics are no longer thermally controlled. However the main imaging system remains operational. Imagery acquired up to the loss will be termed pre-TCAL and has image IDs under 40000, and imagery acquired after this date will be termed post-TCAL and has image IDs over 100,000.

Post-TCAL data relies on ground calibration and pre-TCAL OBCS data for much of its calibration. This data is supplemented by deep space looks as zero references, and scans at angles away from the normal scan direction to quantify the relative performance of the detectors within a band segment (band on an SCA). Moon look data is also being acquired as a calibration source but has not yet been incorporated in the analyses.

The imagery is currently available in two forms: level1b_u data and level1b_r_coreg data. Additional forms are available on request. These data are provided as hierarchical data files (HDF), (http://hdf.ncsa.uiuc.edu/). The level1b_u imagery is unregistered while the level1b_r_coreg imagery is the output of an automated image registration procedure. Both sets of imagery exhibit similar calibration artifacts, but can exhibit very different "registration" artifacts.

Calibration artifacts show up most strongly in near uniform scenes, e.g., water surfaces and clouds, but with suitable processing can be detected in almost any scene. In the following discussion pixel indices will be zero based.

Summary of calibrated response differences:

- The SCAs can differ in their calibrated radiances. For example, bands A and B have lower calibrated radiances on SCAs 2 and 3 than on SCA 1.
- Bands H1 and H2 often exhibit ghosting which is attributed to electronic cross talk.
- Bands H1 and H2 tend to be either noisy, when operated with short integration times, or subject to saturation over cloudy scenes, when operated with large integration times.
- Bands H1 and H2 pixels 57, 136, 137, and 138 on SCA 2 and 12, 13, and 14 on SCA 3 have excess signal in imaging the earth compared to other pixels. As these bands image in an atmospheric absorption band, this excess signal is attributed to out of spectral band leakage. Other structures in these bands, e.g., the periodic patterns on SCA 1, are attributed to smaller amplitude variations in filter performance.
- Dead pixel values are replaced by the averages of adjacent active pixels.
- Missing scan lines are replaced by interpolations from live scan lines.
- Pixels 818 on segment (band on an SCA) B-2, 758 on D-3, 38 on segment F-3, 15 on segment L-3, 85 on M-3, and 28, 31, and 33 on segment O-1 are considered dead.
- Starting with image 28537, pixel 358 on B-3 has been treated as dead.
- Pixel 141 in N-2 has a large offset and saturates easily.
- The on-board calibration system (OBCS) has been fully exploited only for bands J-N, the calibration of bands A-I and O relies almost entirely on the ground calibration.

- The HgCdTe detectors for bands L-N have been the least stable type of detector since launch. They also have relatively high non-linearity. Their drifts are not completely calibrated out by using the OBCS data, and the low dynamic range of most scenes in the thermal infrared can make the remaining artifacts very noticeable.
- Band O has a block of pixels near its dead pixels whose calibrated radiances are about 2% lower than the rest of the segment.

Some artifacts are present in post-TCAL data, but not in pre-TCAL data. These include:
- Focus in bands A-D has degraded from pre-TCAL.
- The lack of an OBCS has made it more difficult to correct detector drifts in bands L, M and N.
- The aging of the on-board gyros sometimes causes pointing problems, particularly for nighttime imagery. This sometimes introduces gaps between the registered SCAs. Sometimes similar imagery is generated deliberately as a form of relative calibration of the detectors.

Some artifacts are present in the level1b_u data products that are not found in the level1b_r_coreg products. These artifacts are due to the lack of registration. Obvious artifacts include:
- The "inactive" detector pixels at the ends of the detector arrays are present in the level1b_u imagery. Their values are simply replicates of the last valid detector pixel
- The alternating of detector pixels between two rows in the Si-PIN bands (A-D) causes detector pixels with odd indices to image the same "line" on the ground at a time different from the detector pixels with even numbered indices.
- A few experimental images have both primary and alternate pixels (an option for bands E-G, I-O) active for some of the bands. When this occurs, the alternate pixels image the same line on the ground at different times from the primary pixels.
- Because SCA 1 is rotated 180^{o} relative to SCA 2 and SCA 3, manually registering SCA 1 to SCA 2 or SCA 3 requires transposing the detector pixel indices in SCA 1.
- The bands within an SCA are not coregistered.

The most noticeable registration artifacts in level1b_r_coreg products are:
- Band to band registration within an SCA. For band A relative to band D one to two pixels near nadir misregistration is not uncommon. For band L relative to band D (in VisLoImage) two or three pixels near nadir misregistration is not uncommon. Per-pixel off-nadir misregistration can be two to four times larger than near nadir.
- In-band registration between SCAs. The size of this error (in pixels) depends on the band being compared, the row, the look angle, and the resampling grid. For band A ten pixels SCA to SCA misregistration is not uncommon. For band L eight pixels SCA to SCA misregistration is not uncommon. Per-pixel off-nadir misregistration can be two to four times larger than near nadir.
- In the areas where SCAs overlap, only the data from one SCA is shown. There is a sharp transition from one SCA to another. This can result in the loss of some data, but makes it easier to interpret the data that remains.
- Areas in the imagery outside the bounds of the band segments are filled with zeros.
- If the arrays are not aligned perpendicular to the ground track, SCA 1 overlaps with one of the other two SCAs more than the other. This effect increases with increasing distance of the band from the focal plane center. In some images for some bands SCA 1 does not overlap at all with one of the two SCAs.
- The starting and trailing edges of a band do not necessarily coincide with the starting and trailing edges of other bands. On those edges there are also artifacts in bands A-D from the alternating rows. Similar artifacts appear when an alternate pixel is selected for bands E-G, and I-O.
- The image is not aligned with latitude or longitude. A level1b_r_geo product, available on request, provides such imagery.
- The image GSD for off nadir looks need not be 5 m for VisImage.
- The resampling algorithm currently used results in increased blurring relative to the level1b_u imagery.
- While we know of no example with the current code, previous versions of the resampling code would sometimes generate artifacts resembling grids, honeycombs, etc. If any such are found in recently processed imagery please let us know so that they can be used as appropriate test cases in further improving the resampling algorithm.